CLAIMS

[1] A hydrogen generator comprising:

a first tubular wall element;

a second tubular wall element disposed outside said first tubular wall element and coaxially with said first tubular wall element;

a tubular water evaporator provided in a tubular space formed between said first and second tubular wall elements;

a tubular reforming catalyst body provided in the tubular space, said water evaporator and the reforming catalyst body being arranged in an axial direction of said first and second tubular wall elements;

a water inlet from which water is supplied to said water evaporator; and

a feed gas inlet from which a feed gas is supplied to said water evaporator; wherein

said hydrogen generator is configured to cause a gas mixture containing steam and the feed gas to flow from said water evaporator to said reforming catalyst body and to reform the gas mixture into a reformed gas containing hydrogen.

[2] The hydrogen generator according to claim 1, wherein the reformed gas is caused to flow from an axial end of said reforming catalyst body.

[3] The hydrogen generator according to claim 2, wherein said water evaporator is disposed under said reforming catalyst body.

[4] The hydrogen generator according to claim 1, wherein said first and second tubular wall elements are each constructed of a cylindrical seamless pipe.

[5] The hydrogen generator according to claim 4, further comprising:

a burner configured to combust a combustible gas to generate a combustion gas; and

a third tubular wall element disposed inward of said first tubular wall element and coaxially with said first tubular wall element, wherein the combustion gas is caused to flow in a tubular space which is a combustion gas passage formed between said first and third tubular wall elements.

[6] The hydrogen generator according to claim 5, wherein said burner is oriented to cause a flame to be emitted upward from said burner.

[7] The hydrogen generator according to claim 6, wherein said burner is disposed in an internal space of said third tubular wall element, said hydrogen generator further comprising:

a first lid element disposed with a gap between said first lid element and an upper end of said third tubular wall element so as to close an upper end of said first tubular wall element, wherein the combustion gas generated in said burner is caused to flow from an interior of said third tubular wall element into the combustion gas passage through the gap.

[8] The hydrogen generator according to claim 7, wherein said first tubular wall element is provided with a combustion gas outlet through which the combustion gas flowing in the combustion gas passage is guided to outside, and a combustion gas exhaust pipe is connected to said first tubular wall element to allow the combustion gas flowing out from the combustion gas outlet to be guided radially and downward of said first tubular wall element.

[9] The hydrogen generator according to claim 7, further comprising a width equalizing means for reducing a variation in a width of the combustion gas passage to equalize the width over an entire region in a circumferential direction of the combustion gas passage.

[10] The hydrogen generator according to claim 9, wherein said width equalizing means includes a plurality of protrusions that have equal height and protrude from said third tubular wall element toward said first tubular wall element, and tip ends of the protrusions are configured to contact said first tubular wall element.

[11] The hydrogen generator according to claim 10, wherein the protrusions are formed on said third tubular wall element such that the protrusions are arranged to be spaced a predetermined distance apart from each other in a circumferential direction of said third tubular wall element.

[12] The hydrogen generator according to claim 9, wherein said width equalizing means includes a flexible rod element that is disposed to extend in a

circumferential direction of said third tubular wall element and has an equal cross-section, said rod element being sandwiched between said first and third tubular wall elements.

[13] The hydrogen generator according to claim 12, wherein said rod element is a round rod having an equal diameter.

[14] The hydrogen generator according to claim 1, wherein said first tubular wall element is provided with a porous metal film on an outer peripheral surface thereof, and said water evaporator has a water reservoir that is formed between the porous metal film and an inner peripheral surface of said second tubular wall element.

[15] The hydrogen generator according to claim 14, wherein the porous metal film is provided over an entire outer peripheral surface of said first tubular wall element.

[16] The hydrogen generator according to claim 4, further comprising:

a tubular cover that is configured to cover said second tubular wall element and forms a double-walled pipe along with said second tubular wall element, wherein the reformed gas flowing out from said reforming catalyst body is caused to flow a tubular space between said second tubular wall element and said tubular cover.

[17] The hydrogen generator according to claim 16, further comprising:

a flexible rod element disposed at a position of the reformed gas passage to extend in a circumferential direction of said second tubular wall element, and the rod element is sandwiched between said second tubular wall element and said tubular cover.

[18] The hydrogen generator according to claim 5, wherein said burner is oriented to cause a flame to be emitted downward from said burner.

[19] The hydrogen generator according to claim 18, further comprising:

a combustion tube that is connected to said burner and is configured to guide the combustion gas downward, wherein the combustion gas passage includes a first tubular combustion gas passage formed between said third tubular wall element and said first tubular wall element, and a second tubular combustion gas passage formed between said combustion tube and said third tubular wall element, and wherein the combustion gas flowing out from said combustion tube is caused to flow into the first combustion gas passage through the second combustion gas passage.

[20] The hydrogen generator according to claim 19, further comprising:

a second lid element that is disposed with a gap between said second lid element and an upper end of said third tubular wall element and is connected to said burner so as to close an upper end of said first tubular wall element; and

a separating element that is disposed opposite to a lower end of said

combustion tube and is configured to separate an interior of said third tubular wall element.

[21] The hydrogen generator according to claim 20, wherein said lid element is a flange portion formed at a base end portion of said combustion tube.

[22] The hydrogen generator according to claim 1, further comprising:

a gas mixture promoting means configured to promote mixing of steam in an interior of said water evaporator with the feed gas supplied through said feed gas inlet.

[23] The hydrogen generator according to claim 22, wherein said gas mixture promoting means includes a porous metal portion having a number of pores through which the gas mixture flows.

[24] The hydrogen generator according to claim 22, further comprising:

an annular support element that is disposed between said first and second tubular wall elements and is configured to support said reforming catalyst body;

a first annular separating plate disposed to cover an upper end of said water evaporator; and

a boundary space defined by said support element and said first annular separating plate;

wherein said gas mixture promoting means includes a hole formed on said first annular separating plate, and

wherein the feed gas and the steam in the interior of said water evaporator are caused to gather to the hole to be mixed, and flow into said boundary space.

[25] The hydrogen generator according to claim 24, further comprising:

a second separating plate configured to divide said boundary space in two;

a first sub-space defined by said first and second separating plates; and

a second sub-space defined by said second separating plate and said support element, wherein

said gas mixing promoting means includes a bypass passage connecting an interior of said first sub-space to an interior of said second sub-space.

[26] The hydrogen generator according to claim 25, wherein the bypass passage includes a first pipe extending radially outward of said second tubular wall element and a second pipe that is connected to the first pipe and extends in the axial direction of said second tubular wall element so as to pass through said second separating plate.

[27] The hydrogen generator according to claim 26, wherein the second pipe extends in a direction perpendicular to the first pipe.

[28] The hydrogen generator according to claim 25, wherein the gas mixture is caused to flow from said first sub-space into the bypass passage and to flow into said second sub-space toward an inner side in a circumferential direction

of said second sub-space.

[29] A fuel cell system comprising:

a hydrogen generator according to any one of claims 1 through 28; and

a fuel cell configured to generate power using a reformed gas containing hydrogen that is supplied from said hydrogen generator.